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[FROM THE TRANSACTIONS OF THE AMERICAN ELECTROCHEMICAL SOCIETY, Volume XIX, 1911, being the Transactions of the Nineteenth General Meeting, at New York City, April 6, 7, 8, 1911.]

The Advantages of Maine for Electrochemical Industries

BY

C. VEY HOLMAN

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A paper presented at the Nineteenth General Meeting of the American Electrochemical Society, in New York City, April 8, 1911, President Wm. H. Walker in the Chair.

THE ADVANTAGES OF MAINE FOR ELECTRO-CHEMICAL INDUSTRIES.

By C. Vey Holman.
State Geologist of Maine.

The advantages which Maine offers for the development of electrochemical industries may be considered as geographical, meteorological and geological. I shall treat of them briefly in that order.

Let us consider first, then, the geographic advantages. Largest of all the New England States, in fact, falling short by only 1,200 square miles (3,600 sq. km.) of equaling within her borders the aggregate area of all the other five, the State's territorial expanse of 31,500 square miles (87,500 sq. km.) lies as nearly as possible midway between the Equator and the North Pole, the 45th parallel of north latitude practically bisecting the State. Projecting to the eastward far beyond the general Atlantic coast line of her sister States, with a seacoast which, measured in a direct east and west line, spans only a little more than 200 miles (325 km.), but the sinuosities of which are such as to afford nearly 3,000 miles (5,000 km.) of deep, bold shore front on the Gulf of Maine, the State is distinctly maritime. This continental position places Maine in the direct draft of the humid southwest winds from the Gulf of Mexico, the return trades of the north temperate zone, while ensuring the laving of her coasts by a constant circulation of frigid waters discharged from the Arctic Ocean, through the channels bounded by the east coast of Labrador and the west coast of Greenland, into the Gulf of St. Lawrence and thence down along our north Atlantic seaboard, impinging at a distance of some marine leagues upon the northward-flowing thermal waters of the Gulf Stream.

Enjoying thus substantially equal ocean exposures on both the south and east, Maine is favored with winds from practically

two-thirds of the points of the compass blowing directly from the ocean or charged with oceanic influences which render them moist and cool.

All these circumstances, it will be observed, favor periodic—that is to say, regular and constant, rather than non-periodic and fluctuating—precipitation of moisture over the entire geographic area of the State. They also tend to check evaporation and favor storage conservation of stream flow. The winds are variable, shifting with frequency to all points of the compass, and therefore bear in rapid alternation a varied succession of dampness and dryness, of cold and heat, ensuring against excessive drought on the one hand and freshet floodings on the other. The mean annual precipitation ranges from 35.3 inches to 52 inches (90 to 130 cm.), the rainfall being distributed with remarkable uniformity throughout the year, a fair proportion of it occurring in each of the four seasons. The summers, though short, are climatically delightful, beginning with comparative suddenness in June and ending with abruptness in September, to be followed by a bracing autumnal season, of which the languorous Indian summer forms the charming prelude and the period of exhilarating sunny days and clear, frost-laden nights following the harvest moon constitutes the health-giving close. The winters are long, beginning frequently in November, reaching their height in mid-February and finally waning in April. During full five months the ground is frost-bound and heavily blanketed with snow. The coldest place in winter is Fort Kent, on the extreme northern border, where the thermometer frequently reaches as low as 40° F. below zero (—40° C) and the mean annual temperature is 37° F. (+3° C.), and the coolest place in summer is probably the sentinel city of Eastport, with a mean summer temperature of 59° F. (19° C.). Portland enjoys a mean annual temperature of 46° F. (8° C.), and the influence upon the climate of this city by the sea of the Arctic current, of which I have spoken, may be inferred from the presence in the waters of Casco Bay of those delicate Arctic pteropoda, the clionidæ, in enormous numbers.

With no mountains of excessive height—the loftiest, Katahdin, reaching an elevation of only 5,385 feet (1,647 m.)—and these arranged as isolated peaks, rather than in chains; with an average

elevation above sea level for the whole State of something like 600 feet (183 m.), and ranging from 5,200 feet (1,600 m.) down to sea level; with a surface consisting essentially of two great plateau-like slopes, the more extensive facing to the south and draining into the Atlantic, the lesser facing northward and draining into the St. John River; with practically half of its entire territory still heavily forest-clad, uncleared, unsettled and in many respects unknown except for its mantle of living green; gemmed with more than 1,600 bodies of inland water sufficient in size to be denominated lakes, or one lake to every 20 square miles (55 sq. km.) of territory and one square mile of lake surface to every 14 square miles of land surface; laced with more than 5,000 streams of pure and limpid water; with five great drainage basins collecting and conveying seaward the trillion and a quarter cubic feet (thirty-five billion cu. m.) of water annually discharged from its surface by its rivers, Maine may well justify its proud and oft-repeated boast that no other tract of country upon the North American Continent is equally well watered.

Assuming the annual rainfall at an average of 42 inches (107 cm.) over the entire breadth of the State, it has been computed that it would aggregate more than three trillion cubic feet (eighty-six billion cu. m.). The estimated annual discharge by river systems given above is thus clearly seen not to be excessive, as it constitutes but 40 percent of the total precipitation. This computation allows a diurnal discharge of water-power material exceeding three and one-third billion cubic feet (eighty-six million cu. m.). Falling through an average descent of 600 feet (183 m.), this discharge, could it be utilized to the full, would supply a working energy of more than two and a half million horse-power.

Upon the basis of these figures, if the reasoning so far is sound, it will be readily apprehended that, from one standpoint at least, Maine's chief advantage for the development of electro-chemical industries consists in her wonderful dowry of water-power resources. The statements hitherto made support the opening postulate of this paper so far as concerns geographical and meteorological conditions. But geology plays no mean or subordinate part in the problem of the proper development and

conservation of these resources, as well as in demonstrating how phenomenally nature has blessed the State in their regard.

As a general proposition, it may be accepted that the rock formations of Maine are among the most ancient, with a few exceptions either antedating in the period of their formation the appearance of terrestrial life, or, where the contrary is true, having been laid down so early after the introduction of life upon the globe that subsequent geologic events have nearly if not wholly obliterated the evidence of organic remains. The rocks of the State are therefore markedly characterized by non-permeability, induration and capacity to resist the action of erosive agencies. Rocks allied to granite underlie nearly one-half the entire area of the State. This makes practically every interior body of water in Maine a non-leakable, rock-bound, rock-floored reservoir, which can be relied upon to conserve in amplest measure its entire storage capacity over the full period of the year. It also assures permanency in the foundation of all structures such as dams, retaining walls, canals, sluices, powerhouses and factories erected for the purpose of enlarging the storage facilities or employing the power resources of the lake systems. The igneous rocks are not the sole contributors to the stability of the water-power resources of the State, for the enormous masses of definitely stratified rocks underlying more than half the surface area of Maine favor water retention and control of flow by their extreme hardness as well as by the fact that the strike of their stratification is directly across the course of the river currents. Folding and tilting have so inclined their exposures as to produce innumerable ridges and pitches in the river beds, causing steep and broken rapids, cascades and waterfalls to be of frequent occurrence.

Owing to the markedly notable height above sea level of Maine's principal lakes, the sources of all her greater rivers are found at comparatively high elevations. Thus Moosehead Lake, the inland sea of 120 square miles (350 sq. km.), which constitutes the headwaters of the Kennebec River basin, lies at an altitude of 1,023 feet (310 m.) above sea level, some of the tributaries which feed the lake rising at still higher points up to 2,000 feet (600 m.), and in one instance up to 3,000 feet (900 m.) above the coast line, making an average altitude nearly

equal to that of Lake Superior as the source of the St. Lawrence. The Rangeley Lakes, in which the Androscoggin rises at 1,511 feet (460 m.) above sea level, are very nearly as high as Lake Itasca, the source of the Mississippi. Chesuncook Lake, in the Penobscot River, is 900 feet (270 m.) above sea level, but the west branch of the Penobscot above this lake starts at an altitude of nearly 2,500 feet (750 m.). On the headwaters of the St. John River, the Chamberlain Lakes lie more than 900 feet (270 m.) above sea level. The Saco River takes its rise at an altitude of more than 1,800 feet (540 m.). Yet the drainage basins through which these rivers discharge their waters, as compared with the St. Lawrence or the Mississippi, are short and their water-power resources are compactly concentrated in conveniently accessible sections.

The Penobscot, from its extremest headwaters to the sea, traverses, with all its windings, less than 300 miles (500 km.), its main water-power section, from Lake Chesuncook to Bangor, falling 900 feet (270 m.) in some 120 miles (200 km.). Similarly the total length of the St. John River, from its remotest sources to the sea, is but 450 miles (750 km.), of which the upper half are in Maine. The Kennebec River, from Moosehead Lake to the sea, is but 155 miles (250 km.) in length, its principal water-power section being between Moosehead Lake and the capital city of Augusta, at the head of tide water, with a fall in excess of 1,000 feet in its 112 miles (300 m. in 185 km.) of length. The Androscoggin River system in its greatest length, from the sea to the uppermost sources in the New Hampshire hills, is less than 110 miles (185 km.), its chief water-power section, from Rumford Falls to the tide, being 75 miles (125 kw.), although it is in fact a water-power river in its whole length of 150 miles (250 km.) from the lakes to Brunswick. The Saco River flows through a drainage basin of less than 100 miles (165 km.), of which the lower two-thirds only are in Maine, and falls 450 feet (135 m.) from Fryeburg, on the New Hampshire State line, to tide water at Biddeford. The principal water-power section is from Hiram to Biddeford, 35 miles (60 km.), in which distance it falls through a slope of nearly 10 feet to the mile (5 m. to the km.).

These hastily compiled data will serve a useful purpose if

they have demonstrated that in her sources of supply of cheaply utilizable water-power, Maine extends to the electrochemist many desirable advantages.

Her other vast resources will be found amply supplementing her contributions to hydraulic and hydro-electric development.

It is regrettable that there has never been an exhaustive geological survey of the State as a whole. In the early thirties of the last century, Prof. Charles T. Jackson, of Boston, made a geological reconnaissance of a large area, in time extending over several years, and his reports, long since out of print, are remarkable for their accuracy of observation and of statement and for their comprehensiveness in view of the primitive conditions then governing transportation. In 1861 and 1862, Prof. C. H. Hitchcock made another reconnaissance which, coming as it did in the midst of the great crisis of the Civil War, and buried as its results were in the annual reports of the Commissioner of Agriculture, has never been appreciated or realized upon as its merits deserve. For the past ten years the State Survey Commission, of which I have the honor to be the present head, has been steadily collaborating with the United States Geological Survey in a hydrographic, topographic and geologic survey of the State which will ultimately result in the complete mapping of its entire area. Our appropriations, however, have been small and the work has been correspondingly handicapped.

Conditions have not favored the mineral development of the State to the extent which its varied and extensive metalliferous and non-metalliferous deposits deserve. Prospecting and exploitation of these resources have been practically prohibited by the segregation in private ownership of enormous land areas comprising the forested regions, upon which the owners, who, in the majority of cases, secured their original title from the State for mere pittances, have steadfastly pursued the short-sighted and selfish policy of permitting no operations, save those connected with lumbering, to be conducted. As there are no public lands, properly so-called, Maine's once imperial domain of wild lands having been reduced by a system of political pillage to a single township and a few public lots reserved for charitable and educational purposes, successful mining operations, even where ore bodies are known to exist, can be conducted only by securing

title through private purchase, for which the land barons usually disdain to treat. In the more settled portions of the State, however, where land holdings are broken up in smaller parcels, there are many known deposits of commercial importance which it is reasonable to expect the future will see more extensively developed and some of which need only the magic touch of electrochemistry to spring into immense importance.

The iron ores of the Mt. Katahdin region, which for several decades furnished an output of high-grade charcoal iron from a single blast furnace, are of unusual character in their freedom from sulphur and phosphorus. There is a belt of hematite iron ore extending northeastward though several Aroostook County townships, ending in the well-known deposits of Woodstock, New Brunswick, which, with the development of the Aroostook water-powers and the use of the electric furnace, may be counted upon as a future source of supply in commercial abundance, lime and other fluxes being at hand within convenient distance. The feldspar deposits of the State are well known and are increasing their output; and, in connection with their development, gem mining is assuming considerable importance. It is, of course, elementary knowledge that in the production of tourmalines of the highest quality, Maine leads the world. At Catharine Hill, in Hancock County, there is now under development what is confidently believed to be the largest deposit of sulphide of molybdenum on this continent, if not in the world. There is already exposed an enormous ore-tonnage of molybdenite, averaging 2 percent MoS_2, in a granite matrix which carries also gold and silver values of commercial importance as a concentrating proposition. Silver-lead-zinc ores are abundantly found, but have been sparingly worked, owing to inherent complexities which in the past rendered their reduction difficult and unprofitable. I believe electrostatic separation and electric furnace smelting can be made to spell prosperity for the developers of these properties. Maine's copper deposits are extensive, though not worked, and the occurrence at various points in the State of small bodies of tin ores supports a sincere belief which, in common with every geologist since Jackson, I earnestly share, that at some point in the State there will yet be discovered a tin deposit of commercial importance. Jackson early noted the presence of wolfra-

mite in the Blue Hill region as an indication of the presence of tin; cassiterite deposits occur in Kennebec County, and the whole mass of molybdenite-bearing rock at Catharine Hill carries a minute dissemination of tin in cassiterite crystals, as well as in the form of a native alloy with bismuth. Maine's immense quarries of granite, lime and slate are too well known to need comment. Platinum has been located in place in several localities, and graphite of good quality is found at numerous points in commercial abundance.

Add to these natural advantages the fact that all portions of the State are now fairly well served by lines of steam and electric transportation, that freight rates by overland routes are practically everywhere forced into competition with those for water-borne traffic, that vast tidal powers lie unimproved all along the coast, and that the agricultural capacity of the State is sufficient to support a population of millions, whereas to-day Maine, with less than 23 inhabitants to the square mile, is the least densely peopled of any Eastern State but Florida, and I believe there is made out at least a *prima facie* case that Maine offers opportunities and advantages for the development of electrochemical industries unsurpassable by any of her sister commonwealths.

Maine's invitation to both capital and labor is hearty, and should be attractive. Nowhere on earth can be found a more intelligent, more enterprising or more thrifty people than constitute her citizenry, and their hospitality to both the transient sojourner and the permanent settler is unfeigned and unstinted.